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WATER QUALITY EVALUATION. MOAPA VALLEY PUMPING PROJECT, NEVADA

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
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A water quality evaluation to be included in a feasibility report for a proposed Moapa Valley Pumping Project, Clark County, Nevada, and intended to determine the need for, and value of, separable reservoir storage for streamflow regulation to control water quality; to assess the overall impact of the proposed development on water quality; and to recommend, where applicable, water quality control measures for the project.

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WATER QUALITY EVALUATION

MOAPA VALLEY PUMPING PROJECT, NEVADA

An evaluation of the Bureau of Reclamation's proposed Moapa Valley Pumping Project reveals that with adequate treatment municipal, industrial, and other minor waste loadings will not significantly affect water quality for present and projected water uses in the project area. Therefore, no storage in Warm Springs or Bowman Reservoirs is needed to provide flow regulation for maintaining satisfactory organic water quality in the Muddy River. The use of project water for irrigation purposes will result in a 1.8 mg/l increase annually in the total dissolved solids concentration of the Colorado River at Lake Mead. The economic impact of this salinity increase upon water users below Lake Mead is estimated to be $72,000 annually, based on 1968 economic conditions. This appraisal provides an estimate of the effect of salinity increases resulting from the project and will be useful in evaluating and justifying control measures for water quality improvement. Control measures are recommended for incorporation into the construction and development of the project to minimize the adverse effects of salinity. The concentrations of nitrates and phosphates in Muddy River water are now sufficient for the potential development of algal blooms in Warm Springs Reservoir and the Muddy River.

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Federal Water Pollution Control Administration
Pacific Southwest Region
San Francisco, California

November 1969

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I. INTRODUCTION

This water quality evaluation has been prepared for the Bureau of Reclamation, Region 3, U. S. Department of the Interior, Boulder City, Nevada for inclusion in their feasibility report for the Moapa Valley Pumping Project, Nevada. The primary purposes of this evaluation are:

1. To determine the need for and value of separable reservoir storage for streamflow regulation to control water quality;

2. To assess the overall impact of the proposed development on water quality, both inside and outside the project area; and

3. To recommend, where applicable, water quality control measures for the project.

This evaluation was made of the effect of the project now and in the year 2010 in the lower Muddy River drainage area in southern Nevada and in downstream areas of the Colorado River Basin.

This report has been prepared under the authority of and in accordance with provisions of the Federal Water Pollution Control Act, as amended, (33 U.S.C. 466 et seq.) and Executive Order 11288, dated July 2, 1966, at the request of the Bureau of Reclamation. Section 3(b) of the Act requires that consideration shall be given to inclusion of storage for regulation of streamflow for the purpose of water quality control, except that any such storage shall not be provided as a substitute for adequate treatment or other methods of controlling waste at the source. Executive Order 11288 clarifies the purpose of Section 11 of the Act. Section 1(7) of the Executive Order requires consideration of water pollution control needs in the initial stages of planning for each new installation or project.

Basic data used in this evaluation were supplied by the Boulder City Development Office, Region 3, Bureau of Reclamation.

Reconnaissance reports on this project were prepared in 1962 by the Bureau of Reclamation, The Bureau of Sport Fisheries and Wildlife, and the Nevada Fish and Game Department, and an addendum to these reports was published in January 1964. The Nevada Department of Conservation and Natural Resources [1] published a report on the water resources in the project area in 1968, which includes water quality information; however, no previous reports have been prepared by the FWPCA on the water quality aspects of the project.

The proposed Moapa Valley Pumping Project is located in Moapa Valley about 48 miles northeast of Las Vegas within Clark County, Nevada (see Figure 1). The valley, which forms the lower portion of the Muddy River drainage basin, is approximately 25 miles in length

and is divided into three separate areas: Lower Moapa Valley; Upper Moapa Valley; and Meadow Valley Wash. Lower Moapa Valley extends to the Overton Arm of Lake Mead.

The project will make water available for the irrigation of 2,700 acres of new lands in Meadow Valley and 780 acres of new lands in Lower Moapa Valley. Water will be diverted from the Muddy River to Warm Springs Reservoir and delivered through a distribution system to the new lands in Meadow Valley. The water diverted from the Muddy River will be replaced by pumping water from Lake Mead upstream to the Wells Siding Diversion Dam. Water behind Wells Siding Diversion Dam will be diverted to the existing Bowman Reservoir at the upper end of the Lower Moapa Valley or diverted directly to the 3,785 acres of presently irrigated lands and new lands.

II. PROJECT IMPACT ON WATER QUALITY

In order to evaluate the impact of a water resources development project on water quality it is necessary to examine the various factors that influence water quality. The economy and water supply in an area affect the amount and type of water use. It is necessary to develop data on the present and projected economy of the study area in order to estimate future municipal and industrial use of project water and the resulting waste loads. The same economic and demographic data may also be useful in evaluating any water quality control measures incorporated into the project plan. The water use influences waste sources and the quality of water downstream from the point of use. Any change in the quality of water has an economic impact on all downstream water users.

The relationship between water use and water quality is illustrated in Figure 2. Water is diverted by User 1 at "A" and the unused water including wastes are returned to the stream at "B". The quality of water at the next downstream diversion "C" is affected by the quality of water at "A," the depletion of stream flow by User 1 and the quality and quantity of water discharged at "B." Streamflow depletion by User 1 effects the quality at "C" by reducing the volume of streamflow available for assimilation of wastes entering the stream in reach B-C.

LOCAL ECONOMY

Agriculture is the basic economic activity in the Moapa Valley where 4,800 acres are utilized in crop production. Agricultural activities include the growing of horticultural crops, dairying, and beef feeding. There are 5 dairy herds totaling 2,550 cows producing milk for the Las Vegas market. There are also about 5,000 range cattle in the valley. The size of farms in Moapa Valley varies from two acres to 300 acres.

The communities of Overton, Logandale, Glendale and Moapa are located within the project area. Overton is the retail trading center for the area catering to local residents, tourists and fishermen. Agricultural employment predominates in the valley with many persons self-employed on farms, dairy farms, and cattle ranches. Farmers in the valley employ up to 400 migrant workers for crop harvesting at the peak of the shipping season. Other employment is provided by retail and service establishments and four silica sand companies which employ a total of about 40 persons.

Recreation and tourism are important elements in the area economy. The Lake Mead National Recreation Area and the Valley of Fire State Park provide an opportunity for all popular forms of outdoor recreation.

Population in the project area was 737 in 1920, 1,200 in 1950, and is estimated to be 2,400 in 1968. It is conceivable that the present

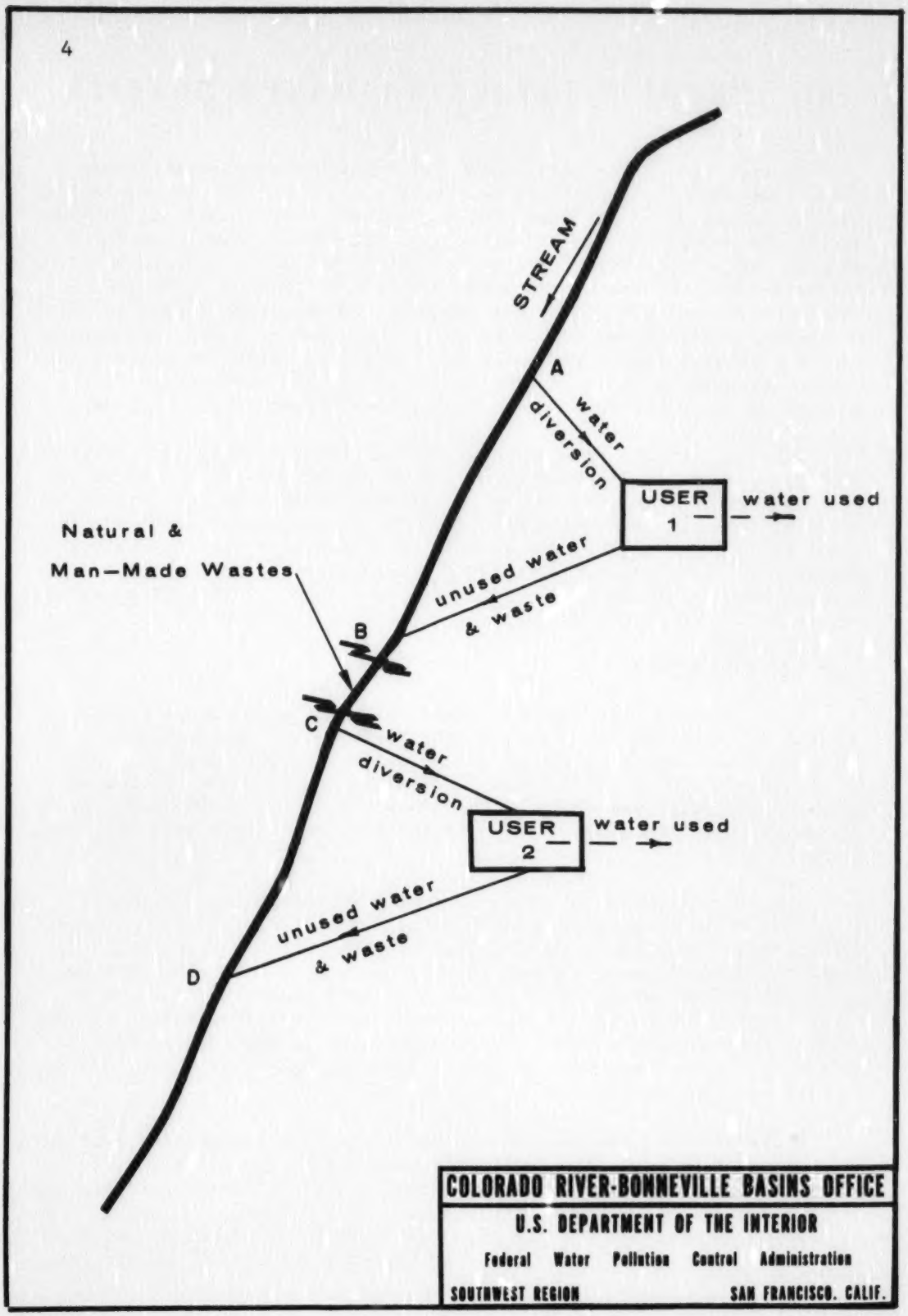

Figure 2. Effect of Water Use on Stream Water Quality

population of Moapa Valley could double by the year 2020. The communities in the valley are actively seeking to provide for future growth by developing a master plan enumerating the needs of present and future populations. The Moapa Valley Pumping Project would stimulate such planning by providing for the establishment of new farms and homes. The economic strength of the valley is agriculture and is expected to remain so. There are no present indications of any other type of economic expansion.

WATER SUPPLY

Water supply in the project area is related to two streams: the Muddy River, and the Meadow Valley Wash. There are intermittent streams which carry surface flow only after severe storms. The U. S. Geological Survey operates two gaging stations on the Muddy River within the project area. The upstream station is located near Moapa, Nevada, and measures the flow from a drainage area of approximately 3,820 square miles of which about 40 square miles contribute directly to surface runoff. Records have been kept at this station for thirty years and during this period the average flow was 33,380 acre-feet annually.

The other station on the Muddy River is located near Glendale, Nevada, 2.4 miles downstream from Meadow Valley Wash. This station measures the flow originating from approximately 6,780 square miles of which about 3,000 square miles contributes directly to surface runoff. During the 17 years in which records have been kept at this station, the average flow was 33,590 acre-feet annually. Below Glendale, Nevada, the Muddy River flows through the Lower Moapa Valley, and thence into the Overton Arm of Lake Mead.

The present modified average annual flow of the Colorado River below Hoover Dam during the period 1941 to 1966 is 10,291,000 acre-feet.(2) The operation of the Moapa Valley Pumping Project will deplete 17,850 acre-feet of this flow annually, thereby reducing the present modified average annual flow of the Colorado River below Hoover Dam to 10,273,150 acre-feet.

WATER USE

Irrigation is the primary water use in Moapa Valley. Approximately 2,650 acres are irrigated presently in the Lower Valley and a total of 2,050 acres are irrigated in the Upper Valley including the Moapa Indian Reservation. The principal crops grown in the area are alfalfa, sudan grass, small grains and, to a lesser extent, green onions, radishes, and tomato sets.

The only other use of water in Moapa Valley is for municipal and industrial purposes. The Moapa Valley Water Company presently obtains one cubic foot per second of water from Warm Springs for municipal use and supplements this during peak periods with water from a well located near Logandale, Nevada. Industrial cooling water is presently obtained

from ground water sources in the Upper Moapa Valley. The Nevada Power Company owns the water rights and can pump up to 2,000 acre-feet from ground water and, in addition, can purchase up to 2,000 acre-feet of Muddy River water from the irrigation company. This flow must be diverted during a period beginning between the 1st and 15th of October, and ending between the 1st and 15th of May.

Future water use in the area is expected to be predominantly for irrigation, especially since the project will provide irrigation service to 2,700 acres of new lands in Meadow Valley Wash and 780 acres of new lands in Lower Moapa Valley. Municipal and industrial water use is not expected to increase in the future.

WASTE SOURCES

Salinity (total dissolved solids) is the major water quality problem in the Moapa Valley area. Irrigation is the activity of man that contributes most to the increase in salinity concentrations. Two factors associated with irrigation cause this increase. First, water is lost by evapo-transpiration with no accompanying loss of salt, thereby causing salinity concentrations to increase. Secondly, the pickup of salts from irrigated lands in excess of quantities required for maintaining a salt balance causes an increase in salinity.

From an analysis of the use of project water for irrigation, it is estimated that 6,960 tons of salt will be added to the Colorado River system annually. This amounts to two tons of salt per acre from the new lands.

Domestic wastes throughout the Moapa Valley are treated with individual septic tank systems and probably will not discharge any significant amounts of organic wastes to the river.

The range cattle and dairy operations are sources of untreated organic waste in the project areas. Although the quantity of waste reaching the Muddy River from these operations is not known, these waste sources are not presently causing any water quality problems in the area. With adequate treatment of wastes at the source, no water quality problems are anticipated from the other industries in the project area.

WATER QUALITY

The major characteristics which determine the suitability of water for irrigation are the concentrations of total dissolved solids and boron, and the relative concentration of sodium to other cations (sodium adsorption ratio). Values of two of these parameters at selected stations on the Muddy River are shown in Table 1. Although the total dissolved solids (TDS) concentrations vary throughout the river basins, past usage of the Muddy River water demonstrates its suitability for irrigating the present cropping pattern. However, because of its high

salinity hazard, the water must be applied carefully to prevent a build-up of salt in the soil. The sodium adsorption ratio of the waters of the Muddy River is within the tolerance limits for the crops that are grown in the Moapa Valley, and boron apparently is not a problem.

Table 1. Average Sodium Adsorption Ratios and Total Dissolved Solids Concentrations of Muddy River Water at Selected Stations (Period of Record July 1965-February 1966)

Location	Sodium Adsorption Ratios	Total Dissolved Solids (mg/l)
USGS Gage near Moapa	3.0	730
Moapa Indian Reservation	3.1	696
USGS Gage near Glendale	3.2	920
Wells Siding Diversion Structure	3.3	958
Overton Wildlife Management Area	4.6	1,776

Part of the water which will be supplied for irrigation will be taken from Lake Mead and pumped to the Lower Moapa Valley in exchange for use of Muddy River water in the Upper Moapa Valley and Meadow Valley Wash. The average TDS concentration of Lake Mead is approximately 734 mg/l. The consumptive use of water and the addition of salts from irrigation of new land will change the water quality of the Muddy River and the Colorado River at Lake Mead. This combined effect will cause a 740 mg/l increase in the TDS concentration of the Muddy River at the Overton Wildlife Management Area below the project area and will cause an increase of 1.8 mg/l in the TDS concentration of the Colorado River at Lake Mead.

The nitrate nitrogen concentration in the water from Warm Springs has reached 2.2 mg/l.[1] Since this spring supplies the majority of Muddy River flow, nutrient analyses were made of Muddy River and Lake Mead water at four locations. The results of these analyses are shown in Table 2. Algal growth potential analyses were also made and the results indicate that a potential for an algal bloom exists in the waters of the Muddy River at Glendale, and near the mouth. An algal bloom may also develop in Warm Springs Reservoir. However, at these locations water uses would not be affected by an algal bloom. Nutrients in the project area come from natural ground water and possibly from agricultural activities such as feedlot and dairy operations, and

fertilizer usage. Increased agricultural activity in the project area may cause future enrichment of the Overton Arm of Lake Mead.

Table 2. Nitrate Nitrogen and Phosphate Concentrations for the Muddy River and the Overton Arm of Lake Mead
(Period of Record August 1968-November 1968)

Location	Nitrate Nitrogen (mg/l)	Phosphate (Total Soluble) (mg/l)
Muddy River above Home Ranch Weir	0.39	0.17
Muddy River at Glendale	0.49	0.28
Muddy River near the Mouth	0.26	0.28
Lake Mead at Stewarts Point	0.35	0.06

Almost all waters in the project area contain more than the recommended amounts[3] of sulfate and total dissolved solids, and are therefore characteristically very hard.[1] The discharge from Warm Springs, which is used for municipal water supply, contains 2.0-2.5 mg/l of fluoride;[1] whereas the optimum control limit recommended by PHS for drinking water in this area is 0.7 mg/l.

ECONOMIC IMPACT

The annual increase in salinity of the Muddy River at the Overton Wildlife Management area of 740 mg/l will have no significant economic impact between the project area and Lake Mead because there are no water uses anticipated in this area. However, the 1.8 mg/l increase in salinity at Lake Mead resulting from the use of project supplied water has a detrimental effect to all Colorado River water users below that point. Data developed by FWPCA's Colorado River Basin Water Quality Control Project indicate that a 1.8 mg/l annual salinity increase at Lake Mead will result in an average annual equivalent penalty cost of about $72,000 based on 1968 economic conditions. This figure is based on a 100-year period of analysis, beginning in 1968, at an interest rate of 4 7/8 percent. These figures include only the direct effects upon agricultural, municipal and industrial water users below Hoover Dam.

III. WATER QUALITY CONTROL MEASURES

The Colorado River Basin States have established water quality standards, which have been adopted by the Secretary of the Interior. However, due to the complexity of the salinity problem in the Colorado River Basin, the establishment of numerical mineral quality criteria for the Basin's interstate waters has been delayed until sufficient information is available to assure that such standards will be equitable, workable, and enforceable.(4) Nevertheless, according to the Assistant Secretary for Water Pollution Control, (5) "It is the intention of the Secretary that the Department of the Interior and the states pursue active programs to lay the foundation for setting numerical criteria at some future time. These programs should focus on devising and demonstrating salinity control measures and finding ways to revise the legal and institutional constraints that could impede the implementation and enforcement of salinity standards."

In the interim before mineral quality standards are set and while salinity control measures are being investigated, certain general guidelines have been formulated(6) for use in evaluating water resource projects such as the Moapa. These guidelines are summarized in the following statements:

1. Each proposed project must be examined for possible adverse effects on water quality.

2. State and Federal agencies must be made aware of the consequences of project development to water quality deterioration and of opportunities that may exist for better quality control on each project. All practicable means must be employed to prevent deterioration of existing mineral quality conditions.

3. Each project feature must be analyzed and justified in accordance with the principles outlined in Senate Document 97.

The information presented in this report has been developed to permit the proper evaluation of the Moapa Valley Pumping Project in accordance with the above guidelines.

STORAGE FOR STREAMFLOW REGULATION

No storage in Warm Springs or Bowman Reservoirs is needed to provide flow regulation for maintaining satisfactory organic water quality.

Present and projected municipal, industrial and rural organic waste loads within and below the project area can be controlled with adequate treatment at the source.

Mineral water quality will be degraded as a consequence of

irrigation use of water served by this project. This degradation has no significant economic impact in the project area or between this area and Lake Mead; therefore, no flow regulation for mineral quality control to protect uses above Lake Mead is necessary.

Below Lake Mead, mineral quality deterioration will cause downstream water users to suffer an annual economic loss estimated at $72,000 based on 1968 economic conditions, which clearly indicates the need to incorporate all possible water quality controls in the project. The large volume of water stored in Lake Mead results in releases from this reservoir being fairly uniform in mineral quality regardless of any seasonal or annual fluctuations in flow and quality of the Colorado River and its tributaries above the reservoir. Therefore, any regulation of flow achieved by storage of presently available water in Warm Springs or Bowman Reservoirs will not change the quality of water discharged from Hoover Dam unless the volume of water stored in Lake Mead is drastically reduced.

In lieu of providing storage in Warm Springs and Bowman Reservoirs for mineral quality control of project-induced salinity increases below Hoover Dam, other salinity control measures within the project area should be investigated. Any such measures found feasible should be included in the project plan.

WASTE SOURCE CONTROL

Potential salinity control measures may be divided into two categories: water phase and salt phase. The former comprises possibilities for improving water quality by augmenting the water supply, while the latter included prospects for improving water quality by reducing the salt input.

Several water-phase control measures appear to have merit. Phreatophyte eradication on project lands and along canals and drains could decrease loss of water and make more water available for dilution. It should be recognized, however, that phreatophyte eradication may result in loss of wildlife habitat and winter protection for cattle and sheep.

Conservation irrigation(7) which is defined as the use of irrigation and cropping methods that best fit a particular soil, slope, crop, and water supply, is another technique which can result in mineral quality improvement.

Installing closed conveyance systems or lining ditches and canals results in higher delivery efficiencies and consequently improved water quality. Proper land preparation by grading and leveling also conserves water.

Potential salt phase control measures include the careful selection of land to be irrigated and better land drainage facilities. Those

lands naturally high in alkaline or sodic salts should be eliminated from consideration in favor of soils having low natural salt content. The installation of subsurface drains will hasten the initial leaching of irrigated lands and reduce the salt load over a number of years.

The Federal Water Pollution Control Administration, the Bureau of Reclamation, and the Colorado River Basin states are developing a proposed salinity control program. The objective of this program is to minimize future deterioration of the mineral quality of the Basin's water supply.

In order to minimize water quality problems associated with project construction activities, the Bureau of Reclamation specifications should contain clauses making it the responsibility of the contractor to comply with all applicable Federal, State, County and local laws concerning pollution of rivers and streams. This would require the contractor to give careful attention to pollution problems such as disposal of sanitary wastes and production of sediment during construction.

IV. CONCLUSIONS

1. No storage in Warm Springs or Bowman Reservoirs is needed to provide flow regulation for maintaining satisfactory organic water quality in the Muddy River.

2. Irrigation use of water supplied by the project will increase the salinity (total dissolved solids) concentration by 1.8 mg/l in the Colorado River at Lake Mead. This increase in salinity will result in an estimated direct average annual equivalent penalty cost of $72,000 based on 1968 economic conditions.

3. Regulation of flow achieved by storage of presently available water in Warm Springs or Bowman Reservoirs will not change the mineral quality of water discharged from Hoover Dam unless the volume of water stored in Lake Mead is drastically reduced.

4. The concentrations of nitrates and phosphates in Muddy River water are sufficient for the potential development of algal blooms in Warm Springs Reservoir and the Muddy River.

5. Project construction activities may cause water quality degradation in the Muddy River and in Lake Mead unless adequate water pollution control measures are provided.

V. RECOMMENDATIONS

In order to prevent or minimize detrimental effects upon water quality, it is recommended that:

1. The best practicable water quality control measures be incorporated into the construction and development of the project to minimize the adverse effects of salinity associated with the project on downstream water uses.

2. A sampling program be initiated by FWPCA after completion of the project to monitor the possible change in the nutrient level of the Overton Arm of Lake Mead.

3. Provisions be included in construction specifications to assure that appropriate steps are taken by the contractor during project construction to protect the quality of the Muddy River and Lake Mead.

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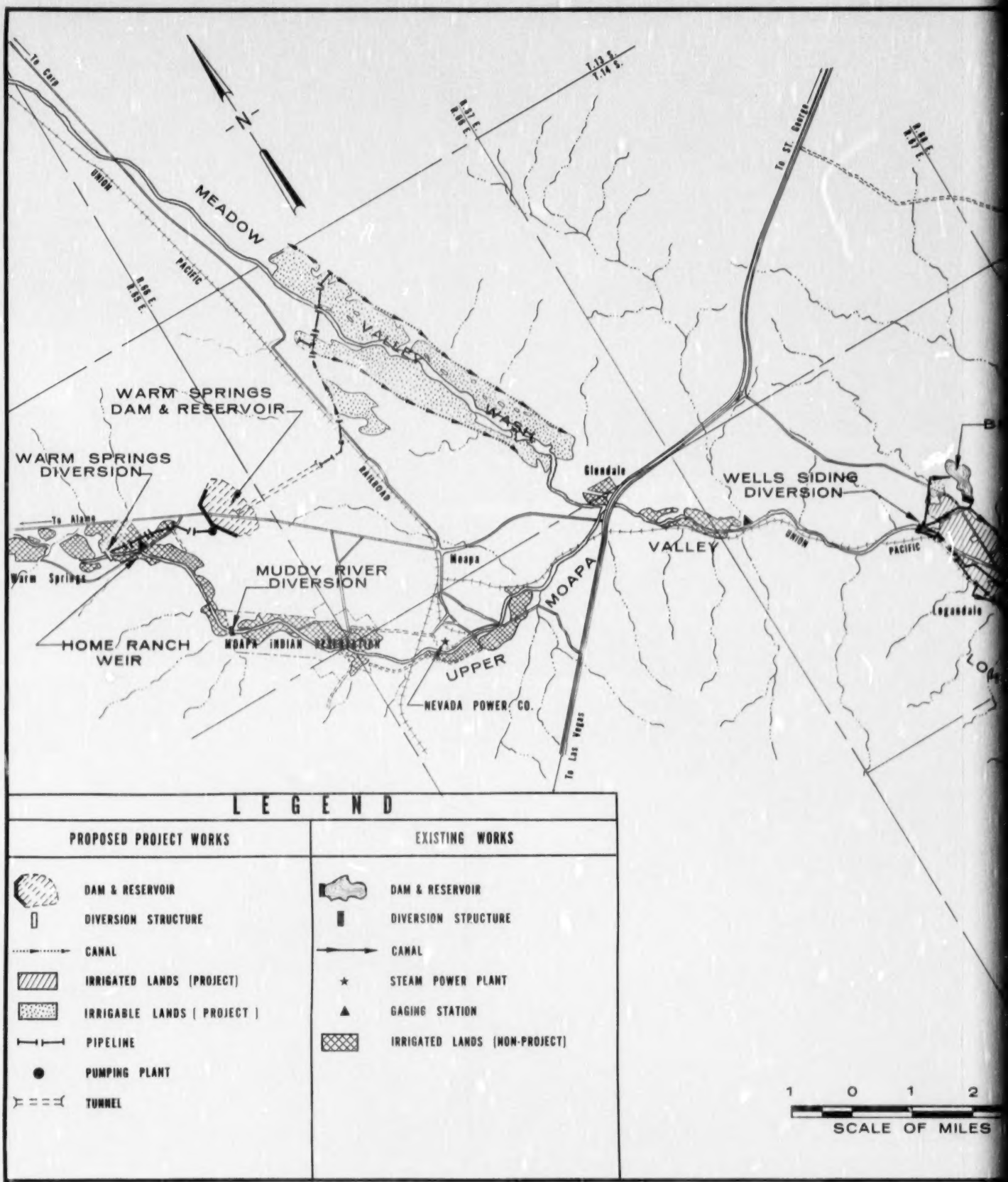
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To ST. GEORGE
MUDDY RIVER
VALLEY
WASH
WARM SPRINGS
DAM & RESERVOIR
WARM SPRINGS
DIVERSION
RAILROAD
Glendale
WELLS SIDING
DIVERSION
To Alamo
Warm Springs
MUDDY RIVER
DIVERSION
Moapa
MOAPA
VALLEY
UNION PACIFIC
Logandale
HOME RANCH
WEIR
MOAPA INDIAN RESERVATION
UPPER
NEVADA POWER CO.
To Las Vegas
LEGEND
PROPOSED PROJECT WORKS
DAM & RESERVOIR
DIVERSION STRUCTURE
CANAL
IRRIGATED LANDS (PROJECT)
IRRIGABLE LANDS (PROJECT)
PIPELINE
PUMPING PLANT
TUNNEL
EXISTING WORKS
DAM & RESERVOIR
DIVERSION STRUCTURE
CANAL
STEAM POWER PLANT
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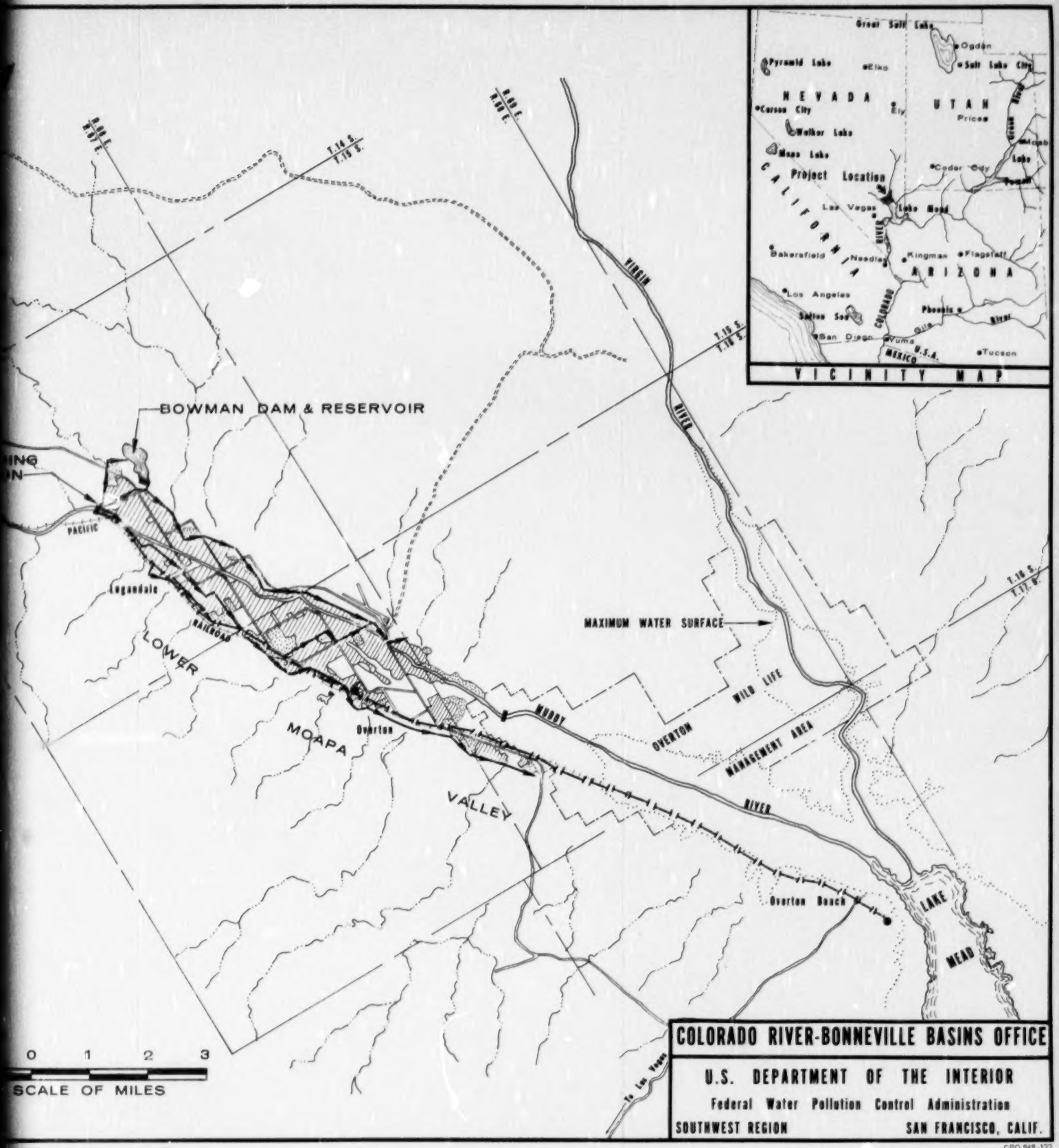

Figure 1. Location Map-Moapa Valley Pumping Project, Nevada